Supporting information:

**Cyclization of Carbonyl Groups onto Alkynes upon Reaction
with IPy_2BF_4 and their Trapping with Nucleophiles: a Versatile
Trigger for Assembling Oxygen Heterocycles**

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Contents

Experimental procedures and characterization data of compounds **2,4, 6** and **7**.

Experimental section:

General: All reactions were conducted using oven-dried glassware under an atmosphere of nitrogen. Dichloromethane was distilled before used from P₂O₅, and DMF was distilled from MgSO₄. The solvents used in column chromatography, hexane and ethyl acetate, were obtained from commercial suppliers and used without further distillation. TLC was performed on aluminium-backed plates coated with silica gel 60 with F₂₅₄ indicator (Merck). Flash chromatography was carried out on neutral, activated aluminium oxide (50-200 micron). NMR spectra were measured at room temperature on a Bruker AC-200 MHz or Bruker DPX-300 MHz spectrometers. 2D NMR experiments were recorded on a Bruker AMX-400 MHz. Chemical shifts are reported in ppm with the solvent resonance as the internal standard (deuteriochloroform: δ 7.26 ppm in ¹H spectra, δ 77.00 ppm in ¹³C spectra). Carbon multiplicities were assigned by DEPT techniques. Infra-red spectra was obtained on a Unicam Mattson 3000 FTIR spectrometer. Elemental analyses were carried out on a Perkin-Elmer 2400 and Carlo Erba 1108 microanalyzers. Melting point were measured on a Buchi-Totoli apparatus and were not corrected.

Starting materials: 2-Alkynylbenzaldehydes were prepared by Sonogashira coupling reaction of 2-bromobenzaldehyde with various terminal alkynes.¹ The same procedure was used to prepare 2-(phenylethynyl)acetophenone and 3-phenylethynyl-2-thiophencarbaldehyde. Trimethylsilyl ketene acetals were prepared according to literature procedure.²

All commercially available compounds were used as received. IPy₂BF₄ is a commercially available reagent from Aldrich, Novabiochem and Galchimia.

General procedure for the synthesis of 4-iodo-1*H*-isochromenes 2 and 6 using IPy₂BF₄ and HBF₄: IPy₂BF₄ (0.37g, 1 mmol, 1 equiv) was dissolved in dry CH₂Cl₂ (10 mL). The solution

¹ Roesch, K. R., Larock, R. C. *J. Org. Chem.* **2002**, 67, 86.

² Rubottom, G. M., Gruber, J. M., Marrero, R., Juve, H. D., Kim, C. W. *J. Org. Chem.* **1983**, 48, 4940.

was cooled at 0°C and tetrafluoroboric acid, 54% solution in diethyl ether (0.14 mL, 1.1 mmol, 1.1 equiv) was added. After 10 min., the corresponding 2-alkynylbenzaldehyde (1 mmol, 1 equiv) was added and the solution was stirred during 30 min. at room temperature. After this time, the nucleophile (1.2 mmol, 1.2 equiv) was added and the solution was further stirred until disappearance of starting benzaldehyde (reaction times are given in Equations 2 and 4). The reaction mixture was quenched with saturated aqueous NaHCO₃ and vigorously stirred. The organic layer was washed with a 5% aqueous solution of Na₂S₂O₃ (50 mL) and water (50 mL); dried over sodium sulphate and concentrated. The crude were purified by flash column chromatography (neutral aluminium oxide, hexane/EtOAc) to afford pure compounds **2**, **6**.

For the reaction of 3-phenylethynyl-2-thiophencarbaldehyde, the same procedure was used.

General procedure for the synthesis of 4-iodo-1-methoxy-1*H*-isochromenes **2 using IPy₂BF₄ and trimethylborate:** Trimethylborate (0.22 mL, 2 mmol, 2 equiv) was added to a solution of IPy₂BF₄ (0.37g, 1 mmol, 1 equiv) in CH₂Cl₂ (10 mL) at 0°C. After 10 min., the corresponding 2-alkynylbenzaldehyde (1 mmol, 1 equiv) was added and the solution was stirred at room temperature until disappearance of starting aldehyde. The reaction mixture was quenched with saturated aqueous NaHCO₃. The organic layer was washed with a 5% aqueous solution of Na₂S₂O₃ (50 mL) and water (50 mL); dried over sodium sulphate and concentrated. The crude were purified by flash column chromatography (neutral aluminium oxide, hexane/EtOAc) to afford pure compounds **2**.

Synthesis of 1,3-dihydro-3-[(*E*)-1-iodo-1-phenylmethylene]-1-methoxy-1-methylisobenzofuran **4:**

a) Using IPy₂BF₄ and HBF₄: To a stirred mixture of IPy₂BF₄ (0.37 g, 1 mmol, 1 equiv) in CH₂Cl₂ (10 mL) at -60°C was added tetrafluoroboric acid, 54% solution in diethyl ether (0.14 mL, 1.1 mmol, 1.1 equiv). After 10 min., 2-(phenylethynyl)acetophenone (0.22 g, 1 mmol, 1 equiv) was added. After the mixture was stirred for 30 min., methanol (48 µL, 1.2 mmol, 1.2 equiv) was added and the resulting solution was stirred at -60°C for 24h. The reaction mixture was quenched with saturated aqueous NaHCO₃. The organic layer was washed with a 5%

aqueous solution of Na₂S₂O₃ (50 mL) and water (50 mL), dried over sodium sulphate and concentrated. The crude was purified by flash column chromatography (neutral aluminium oxide, hexane/EtOAc) to afford pure compound **4** (80 mg, 21%) and the starting ketone (130 mg).

b) Using IPy₂BF₄ and trimethylborate: Trimethylborate (0.22 mL, 2 mmol, 2 equiv) was added to a solution of IPy₂BF₄ (0.37g, 1 mmol, 1 equiv) in CH₂Cl₂ (10 mL) at -60°C. After 10 min., 2-(phenylethynyl)acetophenone was added (0.22 g, 1 mmol, 1 equiv) and the resultant solution was allowed to reach 0°C for 24h. Then, the reaction mixture was quenched with saturated aqueous NaHCO₃; washed with a 5% aqueous solution of Na₂S₂O₃ (50 mL) and water (50 mL), dried over sodium sulphate and concentrated. Flash column chromatography (neutral aluminium oxide, hexane/EtOAc) gave the pure compound **4** (182 mg, 48%) and the starting ketone (75 mg).

Synthesis of 3-Butyl-1-methoxy-4-phenylethynyl-1*H*-isochromene: To a mixture of compound **2d** (0.34 g, 1 mmol, 1 equiv), bis(triphenylphosphine)palladium(II) chloride (24 mg, 3.5 mol%), copper(I) iodide (15 mg, 8 mol%) and triethylamine (0.55 mL, 4 mmol, 4 equiv) was stirred in DMF for 1 hour. Then, phenylacetylene (0.13 mL, 1.2 mmol, 1.2 equiv) was added and the solution was heated at 80°C for 3 days. The reaction mixture was filtered through Celite and solvent was removed under reduced pressure. The crude product was purified by neutral aluminium oxide column chromatography using hexane/ethyl acetate (50/1) as eluent to give **7** (190 mg, 60%) as yellow oil.

Spectroscopic data of compounds **2**, **4**, **6** and **7**:

4-Iodo-1-methoxy-3-phenyl-1*H*-isochromene 2a. Yellow oil. R_f = 0.29 (Hexane: EtOAc, 10:1). ¹H-NMR (CDCl₃, 200 MHz): 7.8-7.7 (m, 3H), 7.6-7.5 (m, 4H), 7.4 (t, J = 7 Hz, 1H), 7.3 (d, J = 7 Hz, 1H), 6.1 (s, 1H), 3.7 (s, 3H). ¹³C-NMR

(CDCl₃, 75 MHz): 151.6 (C), 137.2 (C), 131.2 (C), 129.9 (2 x CH), 129.8 (CH), 129.6 (CH), 129.2 (CH), 127.8 (2 x CH), 127.7 (CH), 127.0 (C), 125.3 (CH), 99.8 (CH), 73.7 (C-I), 55.9 (CH₃). IR (CH₂Cl₂, cm⁻¹) 3039, 2936, 1052. HRMS (EI) Calcd for C₁₆H₁₃IO₂ 363.9960, Found 363.9964.

4-Iodo-1-isopropoxy-3-phenyl-1H-isochromene 2b. Yellow oil. *R*_f = 0.45

(Hexane: EtOAc, 10:1). ¹H-NMR (CDCl₃, 300 MHz): 7.7 (m, 3H), 7.54 (m, 4H), 7.4 (t, *J* = 7.5 Hz, 1H), 7.2 (d, *J* = 7.5 Hz, 1H), 6.3 (s, 1H), 4.4 (m, 1H), 1.4 (t, *J* =

6.2 Hz, 6H). ¹³C-NMR (CDCl₃, 75 MHz): 151.8 (C), 137.6 (C), 131.4 (C), 129.7 (2 x CH), 129.5 (CH), 129.4 (CH), 129.0 (CH), 127.8 (2 x CH), 127.7 (C), 127.6 (CH), 124.9 (CH), 96.5 (CH), 73.6 (C-I), 69.9 (CH), 23.3 (CH₃), 21.6 (CH₃). IR (CH₂Cl₂, cm⁻¹) 3063, 2968, 1021, 960. HRMS (FAB+) Calcd for C₁₈H₁₈IO₂ (M+H) 393.0352, Found 393.0340. Anal. Calcd for C₁₈H₁₇IO₂: C, 55.12%; H, 4.37%, Found: C, 55.13%; H, 4.38%.

4-Iodo-3-phenyl-1-(2-propynyloxy)-1H-isochromene 2c. Yellow oil. *R*_f =

0.57 (Hexane: EtOAc, 3:1). ¹H-NMR (CDCl₃, 300 MHz): 7.7 (m, 3H), 7.5 (m, 4H), 7.4 (dt, *J* = 1.2, 7.4 Hz, 1H), 7.3 (dd, *J* = 1.2, 6.2 Hz, 1H), 6.4 (s, 1H), 4.6 (dd, *J*

= 2.5, 15.9 Hz, 1H), 4.5 (dd, *J* = 2.5, 15.9 Hz, 1H), 2.6 (t, *J* = 2.5 Hz, 1H). ¹³C-NMR (CDCl₃, 75 MHz): 151.3 (C), 137.1 (C), 131.3 (C), 129.9 (CH), 129.8 (2 x CH), 129.6 (CH), 129.2 (CH), 127.8 (3 x CH), 126.5 (C), 125.5 (CH), 96.4 (CH), 78.7 (C), 75.4 (CH), 74.1 (C-I), 54.7 (CH₂). IR (CH₂Cl₂, cm⁻¹) 3297, 3063, 2150, 1044. HRMS (FAB+) Calcd for C₁₈H₁₃IO₂ 387.9960, Found 387.9966. Anal. Calcd for C₁₈H₁₃IO₂: C, 55.69%; H, 3.38%, Found: C, 55.91%; H, 3.33%.

3-Butyl-4-iodo-1-methoxy-1H-isochromene 2d. Pale yellow oil. *R*_f = 0.34

(Hexane: EtOAc, 10:1). ¹H-NMR (CDCl₃, 200 MHz): 7.5 (d, *J* = 7.9 Hz, 1H), 7.4 (dt, *J* = 1.3, 7.9 Hz, 1H), 7.3 (dt, *J* = 1.3, 7.1 Hz, 1H), 7.2 (d, *J* = 7.1 Hz, 1H),

5.9 (s, 1H), 3.6 (s, 3H), 2.9-2.6 (m, 2H), 1.8-1.6 (m, 2H), 1.6-1.4 (m, 2H), 1.0 (t, *J* = 7.2 Hz, 3H). ¹³C-NMR (CDCl₃, 50 MHz): 154.5 (C), 130.8 (C), 129.5 (CH), 128.4 (CH), 126.8 (CH), 126.6 (C),

125.2 (CH), 99.1 (CH), 73.3 (C-I), 55.4 (CH₃), 36.9 (CH₂), 29.3 (CH₂), 22.1 (CH₂), 13.9 (CH₃). IR (CH₂Cl₂, cm⁻¹) 3029, 2956, 1078. HRMS (FAB+) Calcd for C₁₄H₁₇IO₂ 344.0273, Found 344.0288. Anal. Calcd for C₁₄H₁₇IO₂: C, 48.85%; H, 4.98%, Found: C, 48.05%; H, 5.06%.

3-(Cyclohex-1-enyl)-4-iodo-1-methoxy-1H-isochromene 2e. Yellow oil. R_f = 0.43 (Hexane: EtOAc, 10:1). ¹H-NMR (CDCl₃, 200 MHz): 7.5 (dd, J = 1.0, 7.7 Hz, 1H), 7.4 (dt, J = 1.5, 7.7 Hz, 1H), 7.3 (dt, J = 1.3, 7.2 Hz, 1H), 7.1 (dd, J = 1.3, 7.2 Hz, 1H), 6.1 (m, 1H), 5.9 (s, 1H), 3.6 (s, 3H), 2.4-2.2 (m, 4H), 1.80-1.7 (m, 4H). ¹³C-NMR (CDCl₃, 75 MHz): 153.8 (C), 135.2 (C), 132.9 (CH), 131.3 (C), 129.6 (CH), 129.4 (CH), 127.2 (CH), 127.0 (C), 125.2 (CH), 99.4 (CH), 71.9 (C-I), 55.6 (CH₃), 26.7 (CH₂), 24.9 (CH₂), 22.3 (CH₂), 21.6 (CH₂). IR (CH₂Cl₂, cm⁻¹) 3034, 2926, 1024. HRMS (FAB+) Calcd for C₁₆H₁₇IO₂ 368.0273, Found 368.0273.

1,3-dihydro-3-[(E)-1-iodo-1-phenylmethylene]-1-methoxy-1-methylisobenzofurane 4. Pale yellow solid (*unstable*). R_f = 0.43 (Hexane: EtOAc, 10:1). ¹H-NMR (CDCl₃, 200 MHz): 8.8 (d, J = 6.7 Hz, 1H), 7.7-7.5 (m, 4H), 7.45-7.3 (m, 3H), , 7.25 (d, J = 7.2 Hz, 1H), 3.0 (s, 3H), 1.7 (s, 3H). ¹³C-NMR (CDCl₃, 75 MHz): 150.9 (C), 142.6 (C), 141.7 (C), 133.8 (C), 130.3 (2 x CH), 130.0 (CH), 128.9 (CH), 127.7 (2 x CH), 127.3 (CH), 125.5 (CH), 122.1 (CH), 110.1 (C), 65.9 (C-I), 50.5 (CH₃), 25.6 (CH₃). LRMS (EI) m/z (%) 378(M⁺, 29), 347(14), 281(24), 251(M⁺ - I, 100), 207(90), 191(35).

1-Allyl-4-iodo-3-phenyl-1H-isochromene 6a. Pale yellow solid (mp = 46°C, dec). R_f = 0.52 (Hexane: EtOAc, 10:1). ¹H-NMR (CDCl₃, 300 MHz): 7.7 (m, 2H), 7.6 (dd, J = 1.0, 7.7 Hz, 1H), 7.5-7.45 (m, 3H), 7.4 (dt, J = 1.3, 7.7 Hz, 1H), 7.3 (dt, J = 1.3, 7.5 Hz, 1H), 7.0 (d, J = 7.5 Hz, 1H), 6.0 (m, 1H), 5.35 (dd, J = 5.3, 7.9 Hz, 1H), 5.25 (m, 2H), 2.9 (m, 1H), 2.7 (m, 1H). ¹³C-NMR (CDCl₃, 75 MHz): 153.8 (C), 136.7 (C), 133.5 (CH),

132.3 (C), 131.1 (C), 130.3 (2 x CH), 129.4 (CH), 129.1 (CH), 128.3 (CH), 127.7 (2 x CH), 127.5 (CH), 123.6 (CH), 118.1 (CH₂), 78.0 (CH), 72.4 (C-I), 38.2 (CH₂). IR (CH₂Cl₂, cm⁻¹) 3060, 1082. HRMS (FAB+) Calcd for C₁₈H₁₆IO₂ (M+H) 375.0246, Found 375.0247. Anal. Calcd for C₁₈H₁₅IO: C, 57.77%; H, 4.04%, Found: C, 56.37%; H, 4.06%.

1-Phenyl-2-(4-iodo-3-phenyl-1H-isochromen-1-yl)ethanone 6b. White

solid (mp = 68°C, dec). *R*_f = 0.25 (Hexane: EtOAc, 10:1). ¹H-NMR (CDCl₃, 200 MHz): 8.0 (d, *J* = 7.4 Hz, 2H), 7.7-7.2 (m, 11H), 7.1 (d, *J* = 7.2 Hz, 1H), 6.1 (dd,

J = 5.0, 7.7 Hz, 1H), 3.9 (dd, *J* = 7.7, 16.7 Hz, 1H), 3.5 (dd, *J* = 5.0, 16.7 Hz, 1H). ¹³C-NMR (CDCl₃, 75 MHz): 196.5 (C=O), 153.9 (C), 136.7 (C), 136.2 (C), 133.3 (CH), 132.6 (C), 130.9 (C), 130.4 (2 x CH), 129.5 (CH), 129.3 (CH), 128.6 (3 x CH), 128.1 (2 x CH), 127.9 (CH), 127.6 (2 x CH), 123.2 (CH), 74.4 (CH), 72.4 (C-I), 42.0 (CH₂). IR (CH₂Cl₂, cm⁻¹) 3057, 1685, 1087. HRMS (EI) Calcd for C₂₃H₁₇IO₂ 452.0273, Found 452.0272.

Methyl 2-(4-iodo-3-phenyl-1H-isochromen-1-yl)-2-methylpropanoate 6c.

Yellow oil. *R*_f = 0.35 (Hexane: EtOAc, 10:1). ¹H-NMR (CDCl₃, 300 MHz): 7.7 (m, 2H), 7.5 (dd, *J* = 1.3, 7.7 Hz, 1H), 7.5-7.4 (m, 4H), 7.25 (dt, *J* = 1.3, 7.5 Hz, 1H),

6.9 (d, *J* = 7.5 Hz, 1H), 5.6 (s, 1H), 3.7 (s, 3H), 1.4 (s, 3H), 1.3 (s, 3H). ¹³C-NMR (CDCl₃, 75 MHz): 175.9 (C=O), 154.7 (C), 136.8 (C), 133.2 (C), 130.0 (2 x CH), 129.4 (CH), 129.2 (CH), 128.8 (CH), 127.7 (2 x CH), 127.1 (CH), 126.1 (C), 125.6 (CH), 82.9 (CH), 72.5 (C-I), 52.2 (CH₃), 49.6 (C), 22.0 (CH₃), 20.3 (CH₃). IR (CH₂Cl₂, cm⁻¹) 3056, 2947, 1727, 1083. HRMS (EI) Calcd for C₂₀H₁₉IO₃ 434.0379, Found 434.0378. Anal. Calcd for C₂₀H₁₉IO₃: C, 55.31%; H, 4.41%, Found: C, 56.41%; H, 4.39%.

Methyl 2-(4-iodo-3-butyl-1H-isochromen-1-yl)-2-methylpropanoate 6d.

Pale yellow oil. R_f = 0.34 (Hexane: EtOAc, 10:1). $^1\text{H-NMR}$ (CDCl_3 , 300 MHz): 7.4-7.2 (m, 2H), 7.1 (t, J = 7.2 Hz, 1H), 6.8 (d, J = 7.4 Hz, 1H), 5.5 (s, 1H), 3.7

(s, 3H), 2.7-2.5 (m, 2H), 1.6 (m, 2H), 1.4 (m, 2H), 1.22 (s, 3H), 1.2 (s, 3H), 0.9 (t, J = 7.3 Hz, 3H). $^{13}\text{C-NMR}$ (CDCl_3 , 75 MHz): 175.9 (C=O), 157.7 (C), 132.6 (C), 128.6 (CH), 128.0 (CH), 126.4 (CH), 125.9 (C), 125.3 (CH), 82.1 (CH), 72.6 (C-I), 52.1 (CH_3), 49.6 (C), 37.1 (CH_2), 28.5 (CH_2), 22.4 (CH_2), 21.6 (CH_3), 20.3 (CH_3), 13.8 (CH_3). IR (CH_2Cl_2 , cm^{-1}) 2960, 1728, 1032. LRMS (EI) m/z (%) 414 (M^+ , 5), 313(100).

Methyl 1-(4-iodo-3-phenyl-1H-isochromen-1-yl)cyclohexanecarboxylate 6e.

Pale yellow solid. (mp = 103-104°C). R_f = 0.39 (Hexane: EtOAc, 10:1). $^1\text{H-NMR}$ (CDCl_3 , 200 MHz): 7.7 (m, 2H), 7.6-7.4 (m, 5H), 7.25 (dt, J = 1.0, 7.2 Hz,

1H), 6.9 (d, J = 7.2 Hz, 1H), 5.4 (s, 1H), 3.7 (s, 3H), 2.5 (m, 1H), 2.3 (m, 1H), 1.7-1.6 (m, 3H), 1.4-1.0 (m, 5H). $^{13}\text{C-NMR}$ (CDCl_3 , 75 MHz): 173.9 (C=O), 154.9 (C), 136.9 (C), 132.9 (C), 130.1 (2 x CH), 129.3 (CH), 128.8 (CH), 128.7 (CH), 127.7 (2 x CH), 126.8 (CH), 126.2 (CH), 125.5 (C), 84.5 (CH), 72.5 (C-I), 54.3 (C), 51.9 (CH_3), 31.2 (CH_2), 29.4 (CH_2), 25.3 (CH_2), 23.0 (CH_2), 22.8 (CH_2). IR (CH_2Cl_2 , cm^{-1}) 2938, 1723, 1220. HRMS (EI) Calcd for $\text{C}_{23}\text{H}_{23}\text{IO}_3$ 474.0692, Found 474.0687. Anal. Calcd for $\text{C}_{23}\text{H}_{23}\text{IO}_3$: C, 58.24%; H, 4.89%, Found: C, 58.27%; H, 4.91%.

Methyl 2-(4-iodo-3-phenyl-1H-isochromen-1-yl)propanoate 6f (1:1

mixture of diastereoisomers). Pale yellow oil. R_f = 0.25 (Hexane: EtOAc, 10:1).

$^1\text{H-NMR}$ (CDCl_3 , 300 MHz): 7.7-7.2 (m, 16H), 7.0 (m, 2H), 5.6 (d, J = 6.8 Hz,

1H), 5.5 (d, J = 9.8 Hz, 1H), 3.7 (s, 3H), 3.6 (s, 3H), 3.4-3.2 (m, 2H), 1.4 (d, J = 6.9 Hz, 3H), 1.1 (d, J = 7.2 Hz, 3H). $^{13}\text{C-NMR}$ (CDCl_3 , 75 MHz): 174.7 (C=O), 173.7 (C=O), 154.1 (C), 153.3 (C), 136.8 (C), 136.7 (C), 135.6 (C), 132.4 (C), 131.9 (C), 131.4 (C), 130.0 (CH), 129.45 (CH), 129.4 (CH), 129.3 (CH), 129.2 (CH), 128.9 (CH), 128.7 (CH), 128.0 (C), 127.8 (CH), 127.7 (CH), 127.6

(CH), 127.2 (CH), 125.6 (CH), 123.9 (CH), 80.2 (CH), 79.3 (CH), 72.9 (C-I), 72.3 (C-I), 51.85 (CH₃), 51.84 (CH₃), 43.8 (CH), 42.1 (CH), 14.0 (CH₃), 12.6 (CH₃). LRMS (EI) m/z (%) 420 (M⁺ 14), 333 (100).

4-(4-Iodo-3-phenyl-1H-isochromen-1-yl)phenol 6g. Orange syrup. R_f = 0.29 (Hexane: EtOAc, 3:1). ¹H-NMR (CDCl₃, 300 MHz): 7.6 (d, J = 7.7 Hz, 1H), 7.5 (m, 2H), 7.4-7.3 (m, 4H), 7.3-7.2 (m, 3H), 6.9 (d, J = 8.7 Hz, 2H), 6.8 (d, J = 7.5 Hz, 1H), 6.2 (s, 1H), 5.5 (bs, 1H, OH). ¹³C-NMR (CDCl₃, 75 MHz): 155.9 (C), 154.5 (C), 136.6 (C), 133.3 (C), 131.1 (C), 130.9 (C), 130.2 (2 x CH), 129.9 (2 x CH), 129.3 (CH), 129.0 (CH), 128.5 (CH), 127.7 (CH), 127.6 (2 x CH), 124.8 (CH), 115.3 (2 x CH), 80.2 (CH), 73.2 (C-I). IR (CH₂Cl₂, cm⁻¹) 3569, 3044, 1174. HRMS (EI) Calcd for C₂₁H₁₅IO₂ 426.0117, Found 426.0119.

4-(4-Iodo-3-phenyl-1H-isochromen-1-yl)-N,N-dimethylaniline 6h. Green solid (mp = 51°C, dec). R_f = 0.34 (Hexane: EtOAc, 10:1). ¹H-NMR (CDCl₃, 300 MHz): 7.6-7.5 (m, 3H), 7.4-7.2 (m, 7H), 6.8-6.7 (m, 3H), 6.2 (s, 1H), 3.0 (s, 6H). ¹³C-NMR (CDCl₃, 75 MHz): 154.6 (C), 150.6 (C), 136.7 (C), 133.4 (C), 131.5 (C), 130.4 (2 x CH), 129.4 (2 x CH), 129.2 (CH), 128.9 (CH), 128.3 (CH), 127.5 (3 x CH), 126.2 (C), 124.8 (CH), 112.1 (2 x CH), 80.6 (CH), 72.9 (C-I), 40.4 (2 x CH₃). IR (CH₂Cl₂, cm⁻¹) 3046, 1612, 1524. HRMS (FAB⁺) Calcd for C₂₃H₂₁NO (M+H) 454.0668, Found 454.0660. Anal. Calcd for C₂₃H₂₀INO: C, 60.94%; H, 4.45%; N, 3.09%, Found: C, 60.40%; H, 4.38%; N, 2.74%.

Methyl 2-[4-iodo-3-(4-nitrophenyl)-1H-isochromen-1-yl]-2-methylpropanoate

6i. Yellow syrup. R_f = 0.56 (Hexane: EtOAc, 3:1). $^1\text{H-NMR}$ (CDCl_3 , 300 MHz):

8.25 (d, J = 9.1 Hz, 2H), 7.8 (d, J = 9.1 Hz, 2H), 7.5 (d, J = 7.7 Hz, 1H), 7.4 (t, J = 7.7 Hz, 1H), 7.3 (t, J = 7.4 Hz, 1H), 6.9 (d, J = 7.4 Hz, 1H), 5.6 (s, 1H), 3.7 (s,

3H), 1.3 (s, 6H). $^{13}\text{C-NMR}$ (CDCl_3 , 75 MHz): 175.8 (C=O), 152.3 (C), 147.9 (C), 143.0 (C), 132.3 (C), 131.1 (2 x CH), 129.5 (CH), 129.1 (CH), 127.9 (CH), 126.0 (C), 125.9 (CH), 123.1 (2 x CH), 83.3 (CH), 74.5 (C-I), 52.3 (CH_3), 49.6 (C), 22.3 (CH_3), 20.0 (CH_3). IR (CH_2Cl_2 , cm^{-1}) 3076, 2949, 1732. HRMS (FAB+) Calcd for $\text{C}_{20}\text{H}_{19}\text{INO}_5$ (M+H) 480.0308, Found 480.0305. Anal. Calcd for $\text{C}_{20}\text{H}_{18}\text{INO}_5$: C, 50.12%; H, 3.79%; N, 2.92%, Found: C, 50.29%; H, 3.80%; N, 3.15%.

Methyl 2-(4-iodo-5-phenyl-7H-thieno[2,3-c]pyran-7-yl)-2-methylpropanoate

6j. Orange oil. R_f = 0.48 (Hexane: EtOAc, 10:1). $^1\text{H-NMR}$ (CDCl_3 , 300 MHz): 7.7

(m, 2H), 7.42 (m, 3H), 7.2 (d, J = 5.1 Hz, 1H), 7.1 (d, J = 5.1 Hz, 1H), 5.9 (s, 1H), 3.8 (s, 3H), 1.45 (s, 3H), 1.4 (s, 3H). $^{13}\text{C-NMR}$ (CDCl_3 , 75 MHz): 175.6

(C=O), 151.4 (C), 137.1 (C), 135.5 (C), 129.7 (2 x CH), 129.2 (CH), 128.8 (CH), 127.6 (2 x CH), 123.0 (CH), 122.8 (C), 81.5 (CH), 62.6 (C-I), 52.1 (CH_3), 49.4 (C), 20.7 (CH_3), 20.5 (CH_3). IR (CH_2Cl_2 , cm^{-1}) 3053, 1734. HRMS (EI) Calcd for $\text{C}_{18}\text{H}_{17}\text{IO}_3\text{S}$ 439.9943, Found 439.9939.

3-Butyl-1-methoxy-4-phenylethynyl-1H-isochromene (7). Pale yellow oil.

R_f = 0.38 (Hexane: EtOAc, 10:1). $^1\text{H-NMR}$ (CDCl_3 , 200 MHz): 7.7 (d, J = 7.7 Hz, 1H), 7.6-7.2 (m, 8H), 6.0 (s, 1H), 3.6 (s, 3H), 2.9-2.6 (m, 2H), 1.9-1.7 (m, 2H), 1.6-1.4 (m, 2H), 1.0 (t, J = 7.4 Hz, 3H). $^{13}\text{C-NMR}$ (CDCl_3 , 75 MHz): 160.5 (C),

131.0 (2 x CH), 129.5 (CH), 129.0 (C), 128.2 (2 x CH), 127.6 (CH), 126.5 (CH),

125.5 (CH), 125.4 (C), 123.9 (C), 122.9 (CH), 99.4 (CH), 97.3 (C), 94.7 (C), 84.0 (C), 55.3 (CH_3), 32.6 (CH_2), 29.4 (CH_2), 22.0 (CH_2), 13.8 (CH_3). IR (CH_2Cl_2 , cm^{-1}) 3084, 2961, 2207. LRMS (EI) m/z (%) 318 (M^+ , 60), 287 (100).

Compound 2a:

Compound 2b:

Compound 2c:

Compound 2d:

Compound 2e:

Compound 4:

Compound 6a:

Compound 6b:

Compound 6c:

Compound 6d:

Compound 6e:

Compound 6 f:

Compound 6g:

Compound 6h:

Compound 6i:

Compound 6j:

Compound 7: